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medical. He enjoyed immensely the position of active patron of the Lowell Lectures. He was very punctual and conscientious in his attendance at the opening of all these courses.

He was a constant attendant at, and an occasional contributor to the meetings of the Academy. He took a keen interest in the practical welfare of the society and of its members.

Dr. Cotting was a sceptic; his habit of mind was negative in belief. This applied to his own medical belief and to all the range of psychical events. He was a good observer, and clear-headed in his views. He was a positivist but not a dogmatist. He had many virtues which are called old-fashioned, and he was obstinate in his convictions.

His benevolence was self-sacrificing, and therein differed from common giving, — in faith nothing, in charity all. Those virtues which were fundamental in the Puritan remained vital in him; they were tempered by great kindness, but never weakened by concession. The frittering attrition of modern luxury and material advancement softens or weakens most characters, — a few, like our deceased brother's, remain sharp, clear-cut, in all time, like the basalt or granite of Egypt.

David W. Cheever.

ALVAN GRAHAM CLARK.

In St. Paul's cathedral is a simple tablet, and on it are these words, " Si monumentum requiris circumspice." To epitomize the life of a noted man is not an easy task. To remove the difficulty by entering upon a panegyric and an extension of details is less promising still. It remains, then, to carve a simple tablet by speaking briefly of his life and work, leaving to the good judgment and recollection of the reader the supreme prerogative of accurately filling in the details.

Alvan Graham Clark was born in Fall River, Mass., July 10, 1832, and died in Cambridgeport, June 9, 1897. His father, Alvan Clark, was born in Ashfield, Mass., March 8, 1804, and was a descendant of Thomas Clark, one of the early Pilgrim settlers. His mother was Maria (Pease) Clark. He had two sisters and one brother, George Bassett Clark, who was born in Lowell, February 14, 1827, and died in Cambridge, January 2, 1892.

The life of Alvan G. Clark is largely involved in the establishment and progress of the optical firm of which he was a member. His father, Alvan Clark, the founder of the firm, was originally a portrait painter, and early developed an unusual capacity for delicate manipulation. His attention was first called to lens making by an attempt of his son George to construct a telescope while a student at Andover. The books represented it as a very difficult thing. However, genius knows no limitations, and, without previous knowledge or discipline, the work was commenced and a telescope successfully made in the year 1846.

The work thus begun soon became a permanent occupation. Painting was exchanged for telescope making, and, about 1850, the house of Alvan Clark and Sons established. Both the sons inherited the father's skill, and entered into the work with him. Upon his death, the business was carried on by the sons together, and, upon the death of George, by Alvan alone.

Alvan Graham Clark was pre-eminently a self-made man. Inheriting to a remarkable degree the talents of his father, and with a fair amount of common school education, he carried lens making to the highest state of perfection the world has ever seen, so that a so called mechanical occupation was transferred to the realm of high art. But to make a good lens, good glass is necessary, and for a time the impossibility of obtaining good disks of large size seemed to present a barrier to the progress of telescope making. Fortunately this has been overcome in recent years by several European makers, notably by Feil of Paris and his successor Mantois, and it was upon this firm that Mr. Clark always relied.

In fact, disks sent by them were frequently rejected. Sometimes a lens would be nearly completed, and, with the gathering in of the last rays of light, a slight vein would be seen. Invariably the wellnigh completed lens was rejected and days of labor lost, for Mr. Clark would say, "I will keep up the standard of my work." As a result, the exquisite definition and clean cut images always confirmed the high standard of excellence set by the maker.

To make a lens is by no means an easy task. When one considers that not merely the chromatic and spherical aberration which relate to color and general figure proper have to be regarded, but also roundness, balance of figure, and several other considerations, it becomes evident that to construct a glass of the highest excellence is a very difficult task. To accomplish this, one must have not only a keen eye to see the defects, but good judgment and consummate skill to remove them without the incorporation of others.

One of the salient features of the Clarks' work was the method of local correction. This, although not wholly new in principle, was early adopted by them, and so extended and specialized that it has been called distinctively the Clark method. It reached its highest manifestation and refinement as used by the subject of this sketch, and may briefly be described as follows. After a lens has been ground with emery, it is polished with rouge on a bed of pitch or coal tar, the spherometer being frequently applied to see that it is approaching the desired curvature. But, although the spherometer will easily detect an irregularity of the fifty-thousandth of an inch, it is far too crude to satisfy the highest demands of science, so that recourse must be had to some other alternative, for even an irregularity of a few millionths of an inch must not be disregarded. It is here that the method of local correction comes in to remove the difficulty. The lens is now carried to the dark room and tested on an artificial star, the eye being placed at the focus. If the light is uniformly distributed over the whole surface and all the rays come to a sharp point, the lens is in good figure, but such a condition would be extremely rare. Portions of the surface will almost inevitably be brighter than others, indicating slight irregularities of curvature. These must be eliminated by returning the lens to the tool and removing the slight elevations by judicious polishing at these points. The lens must also be frequently inserted in the telescope tube and tested on an actual star at night. After this, the special local work begins. This consists in taking some rouge upon the finger and changing the curvature by delicate abrasion at those points which need correction, frequently testing the lens to see that the desired result is being obtained. Here the work is carried to millionths of an inch, for in a 6-inch lens of 90 inches focus, all the rays of light must be shot through a focal point $\frac{1}{2400}$ of an inch in diameter. By tests with the polariscope, however, it may be found that the glass is not quite homogeneous in density, though without any definite flaw. In such a case the curvature must be changed to obviate this condition, so that the best lenses are not always true curves. As an instance of the amount of labor involved in local correction and testing, it may be mentioned that the great Lick telescope of 36 inches diameter was removed to the yard with its attendant risk, attached to the great tube, and tried on stars on fifty-two different nights, beside all the testing in the dark room. It becomes evident, then, that to see the defects, judge correctly of their character, and remove them without incorporating others, demands the keenest eye, the most delicate judgment, and exquisite manipulation, and it was here that Mr. Clark stood unrivalled.

Among the principal telescopes of the Clarks, and to which the subject of this sketch contributed the benefit of his judgment and skill, may be mentioned one of 18¾ inches aperture for the Northwestern University, now located at Evanston, Ill. The next increase in size was marked by the construction of the Princeton refractor of 23 inches aperture. After this, a lens of 26 inches was made for the Naval Observatory at Washington, and one of about 26½ inches for the Leander McCormick Observatory of the University of Virginia. Then followed the 30-inch refractor for the Imperial Observatory at Pulkowa, for which a gold medal was awarded by the Russian government. Finally, as the last of the joint productions of the Clarks, came the famous Lick refractor of 36 inches aperture. It may be added that Mr. Alvan G. Clark did, practically, all the work on this lens, and brought it to its final perfection.

After the death of his brother George, he became sole manager of the firm. In this capacity he either made or superintended the construction of several great lenses, besides many smaller ones. These include the 20-inch lens for the Denver Observatory, one of 24 inches for Mr. Percival Lowell, the 24-inch Bruce Photographic telescope for the Harvard Observatory station at Arequipa, Peru, and, finally, as a crowning triumph, the great Yerkes lens of 40 inches in diameter.

This last he accompanied to its final destination, and superintended its mounting only a few days before his death. Beside his optical work, he was a member of several governmental eclipse expeditions, and also the discoverer of a number of close double stars. Nothing gave him more pleasure than the discovery of these difficult doubles, especially as they were all made with Clark glasses. One of his earliest and most important discoveries in this line was that of the companion of Sirius, in 1862, having been made in the yard adjoining the workshop with the newly constructed 18¾-inch lens before it was sent to Chicago. Turning on Sirius one evening, he detected something unusual, and shortly remarked that the star had a companion. This discovery, splendid enough in itself, was all the more so from the fact that, although irregularities in the motion of Sirius had been noticed and theorized upon, he knew nothing of them or of the predicted place of the companion. For this discovery, he received the Lalande Prize of the French Academy of Sciences.

He married, January 2, 1865, Mary Willard, daughter of Joseph Willard. She died on July 10, 1892. They had one son, Alvan, who died when a young man, and three daughters, still living.

In personal appearance and social intercourse Mr. Clark was unusually attractive. With finely cut features, of sympathetic nature and serene temper, he drew to himself a host of friends.

An hour at his workshop was an unusual pleasure, both for the scientific man as well as the ordinary individual, and no one was ever turned away.

His love for the best literature was intense. Shakespeare and the poets were his especial favorites, and, endowed with a remarkably retentive memory, he could quote from them almost indefinitely.

To him death was the inevitable sequel of life, the gate to be opened by a kind and all-wise Providence, and so without fear he met the future.

To make the most superb lenses, in which every slender ray of light shall be forced to bring its message of stellar history to a focal point, and to see these lenses steadily reach a size only considered possible with each successive achievement, — this was the ambition of Alvan Graham Clark, and in him it found complete fulfilment.

Oliver C. Wendell.

ALONZO SMITH KIMBALL.

Doctor Alonzo S. Kimball, who was for a quarter of a century Professor of Physics in the Worcester Polytechnic Institute, was born at Centre Harbor, New Hampshire, in 1843. He was prepared for college at New Hampton Academy, and was graduated from Amherst College in 1866. In 1871, he was called to the Worcester Polytechnic Institute, which had just graduated its first class. He organized the department of Physics, and the Institute was among the first in the country to provide systematic instruction in a physical laboratory. After seven or eight years of great activity and usefulness, shown alike in the development of the important department of which he had charge and in a series of valuable original contributions to physical science, he was, in 1879, attacked by a painful disease, which, in spite of the highest medical skill in both this country and Europe, proved to be incurable, and from the effects of which he died on December 2, 1897. Notwithstanding the steady progress of a malady which entailed nearly continuous suffering, Professor Kimball through all of these years discharged the constantly increasing duties of his position to the great satisfaction of the officers of the Institute and of his hundreds of pupils, to whom his life and work were always inspiring. In addition to his regular work in Worcester he was for several years a lecturer at Mount Holyoke College, of which institution he was also for many years and at the time of his death a trustee. While the Salisbury Laboratories of the Polytechnic Institute were being built, he spent a year in Europe, engaged in the